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Of spiders and simulations

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Article

Of spiders and simulations: artmachines at Studio Tomás Saraceno

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Abstract
This article employs Anne Sauvagnargues' writing on 'artmachines' to explore a series of experiments with spiders and simulations at Studio Tomás Saraceno. These experiments were the first to 'capture' or 'image' the black widow spider's highly complex, three-dimensional web and to investigate its similarity to astrophysical simulations of the universe. To develop the artmachine for cultural geographies of art, and as a grammar for techno-aesthetic and multispecies artistic practices, the article approaches Studio Saraceno's webbed experiments as artmachines, or 'ecologies of images'. In doing so, the article addresses the role of haecceity and simulation to accentuate the many forms of image-making and becoming within and beyond the studio. This account amplifies affective relations between humans, spiders, and webs, relations that emerge before and beyond the gallery or the exhibition. Thinking with artmachines also manifests art's alliances to technology without foreclosing its unique modes of individuation. For these reasons, artmachines may hold promise for cultural geographies of art, creative practice, and production.

Keywords
art, experiment, machine, Saraceno, spiders, simulation

This article begins with an encounter between a black widow spider and the studio of contemporary artist Tomás Saraceno. As part of a project to study the relationships between spider webs and astrophysical simulations, the black widow was invited into Studio Saraceno to 'weave the galaxies' in 2008.[1] As she wove, a team of artists, arachnologists, and architects cared for her.[2] Her eating preferences, resting patterns, and activities were documented. Her web was illuminated, analyzed, and *woven anew* by human practitioners. In the context of the complex debates on multispecies relations in cultural geography and the environmental humanities, in which attentions to 'un-charismatic' and 'monstrous' species have become more commonplace,[3] an interpretation of this spider's situation would vary considerably. Based on the many forms of description and reference applied to her world, some would interpret this black widow as a laboratory animal.[4] For others, the art studio conditions in which the spider was hosted would render her an 'expressive

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medium'.[5] For still others, the spider, the humans, and the various forces in this studio would form a 'cosmo-ecological' web.[6] Each of these perspectives tells a story of a black widow spider in her encounter with an art studio and the technical practices occurring there. While these approaches are valid, in this article I propose a different perspective: one in which the spider and her web participate in reweaving the aesthetic and epistemological relations between practitioners, technologies, and simulations of the universe.

The empirical account I will present here contributes to efforts in cultural geography to develop a grammar for highly instrumented, more-than-human, and transdisciplinary forms of artistic production.[7] I do so by engaging with a particular thread of artistic research at Studio Tomás Saraceno. More specifically, I investigate how the web of a black widow spider, woven in this art studio, became the principal element of a novel *machine*. I interpret 'machine' following Anne Sauvagnargues, drawing upon the work of Deleuze, Guattari, and Simondon.[8] For Sauvagnargues, as for Deleuze and Guattari, a machine is a composition of material, technical, and semiotic elements that hold together in a particular way.[9] This contrasts with the popular conception of the machine as an industrial, automated entity. A machine, for Sauvagnargues, is not a technical apparatus; it includes also the material and social arrangements that make any technical apparatus operable.[10] Sauvagnargues proposes the *artmachine* as an amplification of Deleuze and Guattari's writing on machinic assemblages which sharpens our attention to the 'ecology of images' intrinsic to the practices of art. Such ecologies are not composed of representations or signs. Rather, for Sauvagnargues, an image is 'a capture of force'[11] or 'a movement in matter' that is measured by its affective potential.[12] Such images form through a process of individuation: intervals of detachment from material, psychic, and technical planes through which images 'cohere' or 'concretize'.[13] Subjective perception and subjectification (from identity to the collective subjectification articulated by Guattari) depend on these processes of individuation.[14] Defined as 'apparitions' of individuation[15] or 'movements' in matter, images feature in broad semiotic and expressive zones, including animal worlds, and 'the complex clusters of milieus that radiate from living things'.[16] In the studio practices explored here, images and web-captures manifest epistemic and aesthetic events. These events form an ecology of images tied to mathematics and code, cosmological theories, arachnology, production networks, and cultural semiosis: 'a veritable ecological field of expression'.[17] The task Sauvagnargues sets forth, and one that informs this article, is not to see art as a unity of cultural aesthetics, or as a transcendent zone of human skill, but to explore art's modes of ecological individuation: 'to see art as an *art machine*'.[18]

The primary contribution I make in this paper is to employ Sauvagnargues' writing on *artmachines* to explore a series of experiments with spiders and simulations at Studio Saraceno, and thus, to propose the value of the artmachine for cultural geographies of artistic practice and production. Sauvagnargues' writing has only recently been translated into English, and the uptake of her work in geography has so far been limited. At the same time, artmachines provide a crucial lens for grasping the novelty of techno-aesthetic and multispecies experiments, including those at Studio Saraceno. Indeed, these experiments were the first to 'capture' or 'image' the black widow spider's three-dimensional web and to deduce its similarity to astrophysical simulations of the universe. Intrinsic to this endeavor was a technical process of illuminating, coding, and modeling that produced new web-images, as well as novel associations between humans, spiders, and webs. These images and events are largely absent from scholarly literature on the webbed artworks of Studio Saraceno,[19] although published work on the studio's human-spider 'jam sessions' is emerging.[20] While the histories of mechanical engineering include many cases of 'de-bugging' computers,[21] there are far fewer accounts of technical or studio-art processes coevolving with insects or their designs. In affinity with the living moths that were plucked from the inner relays of the first

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computational machines including the Harvard Mark II,[22] this article conveys how another kind of 'machine' emerged in relation to the web of a spider.

In conversation with cultural geographies that have investigated the axes of artistic coproduction with nonhuman beings and matters,[23] the second contribution I make in this article is to convey the forces of image-making and events of cobecoming in a multispecies, studio-based project. Attention to this ecology of images occurs alongside the story of collaboration expressed by humans and accentuates forms of individuation and subjectivity that exceed the human. In the forthcoming account, then, human practitioners affect and are affected by a spider and her web as they think, work, and weave in new ways. They are also affected by technical entities participating in the process of webbed visualization, materialization, and invention.[24] Tomás Saraceno is an animating figure in this collaboration. However, this account highlights Saraceno's relationships with other practitioners, webs, spiders, simulations, scientific theories, and technological devices, an entire assemblage productive of images that exceed the work of a singular human figure.

In doing so, I take up Williams' challenge to attend to modes of creativity that are distributed among corporeal, material, and technological elements.[25] I approach this challenge by highlighting two elements intrinsic to Sauvagnargues' thinking on artmachines: these are *haecceity* and *simulation*. The term 'haecceity' originates in the work of Duns Scotus and was employed by Deleuze and Guattari in *A Thousand Plateaus* to diagnose a mode of individuation; a 'thisness', that is different from that of a person, a subject, or a thing.[26] Haecceities consist of relations between movement and rest, between what Deleuze and Guattari (following Spinoza) call 'longitude' (speeding up or slowing down) and 'latitude' (the power to affect or be affected).[27] Furthermore, haecceities emerge in events of cobecoming, as in the dance between the wasp and the orchid,[28] or in the unstable relations 'between [an] image and its model'.[29] In turn, simulation is not defined as a copy or imitation, but is rather a motor or 'circuit' of differentiation and novelty.[30] A simulation is always an experimentation, a staging of a process that one can track as it unfolds, and that is open to failure.[31] Haecceity and simulation guide me in grasping the ecology of images that emerges from an experimental coproduction with spiders and webs. In the process, I find that the story of a machine emerging from a spider web is also the story of the cosmos emerging from a machine.

The paper's argument is woven in the following way. I elaborate the approach of the artmachine and the analytics of *haecceity* and *simulation* by weaving these terms through three stages in the artistic experiment that occurred within and beyond Studio Saraceno. In the next section, then, I consider two webs – the spider web and the 'cosmic web' – and discuss their proximity as a *haecceity*. Next, I illustrate the novel *simulation* invented at Studio Saraceno in collaboration with a black widow spider and scientists at the Technical University of Darmstadt. Empirical material is drawn from archival research, exhibition catalogs and essays, and my own interviews with Saraceno's studio team over a 3-year ethnographic project. The fourth section briefly discusses the artwork *14 Billions (Working Title)* that emerged from silk, code, and string.[32] The conclusion further elaborates the artmachine for cultural geographical investments in the machinic assemblages of art.

Haecceity: the spider web and the cosmic web

I begin an engagement with the artmachine and the creative, multispecies experiments at Studio Saraceno by considering how webs produce common lures for artistic and scientific research. Many scholars, from the physical sciences to the humanities, have engaged with the *web* as a metaphor. These have recently included descriptions of living systems,[33] post-modern narratives,[34] and media infrastructures.[35] To a large extent, these works interpret webs abstractly: without material or creaturely qualities. It is notable, therefore, that, since the 1980s, several astrophysicists have suggested that there may be structural homologies between spider webs and the physical cosmos.[36]

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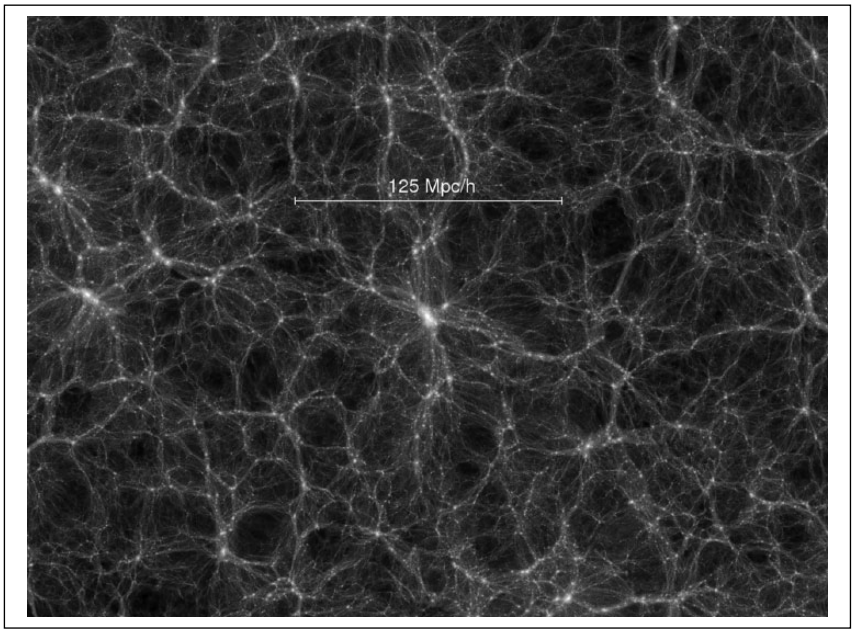

Figure 1. The Cosmic Web. Still image from the Millenium Simulation.
Source: Springel et al. (2005).

The Center for Astrophysics (CfA) Redshift Survey produced the first measurements of the clustering of galaxies.[37] These discoveries led to the development of computer simulations that could model the cosmos' web-like qualities. As these simulations became more sophisticated, references to spider webs as models for cosmic structure proliferated across scientific, popular, and literary writing. Such claims about similarities between spider webs and the *cosmic web* manifest epistemological and aesthetic entanglements across culture and the sciences and animate the machinic milieu from which Studio Saraceno's experiments emerged.

To better grasp the scientific and cultural images and materials informing Studio Saraceno's experiments, let us consider one of the most celebrated simulations of cosmic structure – the *Millenium Simulation*. In 2005, the Max Planck Institute announced in its Research News column that

> [t]he Virgo consortium, an international group of astrophysicists from Germany, the UK, Canada and the USA has just released first results from the largest simulation ever of cosmic structure growth and of galaxy and quasar formation. This 'Millenium Run' used more than 10 billion particles to trace the evolution of the matter distribution in a cubic region of the Universe over 2 billion light years on a side.[38]

An article associated with this news release, published in *Nature*, illustrated how computer-simulated data and large-scale observations could clarify the processes underlying the distribution of matter and dark matter in the universe.[39] The *Millenium Simulation* circulated widely as an image of striking red, purple, and blue tendrils (see Figure 1). One year later, *Astrophysics Journal Letters* stated that 'the NASA/ESA Hubble Space Telescope has found a large galaxy … that is stuffing itself with smaller galaxies caught like flies in a web of gravity'.[40] This galaxy was named the Spiderweb Galaxy because of the way other galaxies were sucked into the black hole at the galaxy's center. The Spiderweb Galaxy was, thus, a metonym for a larger *cosmic web* in which many other black holes, galaxies, and lesser-known entities moved. Although the 'cosmic web' has since

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taken on many connotations,[41] for the purposes of this article, the term 'cosmic web' will refer to the now widespread notion that a web of dark matter forms the backbone of cosmic structure, as visually expressed in the Millenium Simulation (Figure 1).[42] In addition to its scientific meaning, the 'cosmic web' is an alluring image, a narrative element,[43] and a product of the echo chamber of cultural and scientific speculation on the structure of the universe.

A more thorough engagement with the scientific, social, and cultural resonances of the cosmic web is beyond the scope of this article. Instead, I wish to engage with an unusual project that emerged from this machinic milieu of science, culture, and invertebrate construction. For Tomás Saraceno, the proposition of a *structural homology* between spider webs and the cosmic web was a motivation for further attention to spider webs and worlds. As Barad has illustrated with mushrooms and mushroom-clouds, homology is a beacon that can guide modes of inquiry across disciplines and scales.[44] While numerous scientific institutions perfected their computational algorithms, Saraceno and his studio team sought to investigate the relationship between spider webs and the cosmic web with the help of a black widow spider.

At the beginning of this experiment, Saraceno was already an internationally recognized artist with a collaborative, studio-based practice. Born in Argentina, Saraceno studied art and architecture in Buenos Aires and completed postgraduate study at the Städelschule in Frankfurt. In 2008, Saraceno exhibited *Galaxies forming along filaments, like droplets along the strands of a spider's web* at Tanya Bonakdar Gallery in New York. The exhibition's title took inspiration from an article by BBC science writer David Whitehouse, who communicated the discovery that the early universe was '"spongy" with galaxies forming along filaments, like droplets on a spider's web'.[45] At Studio Saraceno in Frankfurt, where the artist had cultivated a research team, a series of questions emerged in relation to astrophysics and spider webs. In 2008 and 2009, Saraceno and colleague Adrian Krell initiated conversations with several of the world's leading arachnologists and astrophysicists. These included arachnologist Peter Jäger and astrophysicist Volker Springel, the latter being the head of the team at the Max Planck Institute that had produced the Millennium Simulation.

In a series of encounters with Springel and Jäger, Saraceno and his team sought to understand the homology between spider webs and the cosmic web. However, in an interview, Springel outlined several reasons why the cosmic web is *not* like a spider web:

> [Pointing to the simulation] The stuff that is colorful here is actually *matter which you can't really see* (Figure 1). On the computer we can paint it and we can illuminate it. What is visible a little bit here is that the backbone of structure of the universe consists of these filament-like structures, which are part of the cosmic web, and along these we find galaxies that are arranged like pearls on a string.[46]

The cosmic web, Springel added, is made up of dark matter, unlike spider webs. Another strange quality of the cosmic web is that it evolves everywhere at once. Springel described a flight in the model: 'It's simultaneously forming everywhere. It is constantly transforming'.[47]

These statements suggest that the cosmic web simulation is not a static structure, but is a shifting product of code, computing power, mathematics, and paradigms in the physical sciences. Following Sauvagnargues and Simondon, the Millenium Simulation is 'a modulation between forces and materials'.[48] These statements also suggest that the relationship between the Millenium Simulation and the physical cosmos is not one of mimicry. Instead, the Millenium Simulation generates a visualization of cosmic structure that appears to match astrophysical observations. The closer the simulation matches physical observations of the cosmos (and vice versa), the greater the *force* of this simulation and its image-products. The Millenium Simulation is, therefore, *not* a representation of the cosmos; *haecceity*, which conveys speeds, slownesses, and capacities to affect and be affected, better highlights the simulation's alluring and 'transforming' qualities. Haecceity

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accounts for the simulation's 'thisness' – its individuation as a particular entity of material, technical, and aesthetic forces.

From the field of arachnology, Jäger offered an interesting alternative reading of the Millenium Simulation. According to Jäger, the differences between a spider web and the Millenium Simulation were a matter of biology. A spider web is the excretion of the animal's body into its milieu. Therefore, in order to weave the cosmic web, the spiders would have to multiply at each node of their web.[49] Jäger speculated on a scenario in which a multiplying universe of spiders might simulate the cosmic web. In turn, Springel speculated that if one could identify the 'rules' according to which a spider makes its web, one could simulate a spider web in the high-performance computer that generated the Millenium Simulation.[50] In suggesting that the Millenium Simulation could be woven by spiders, and a spider web modeled in a supercomputer, Springel and Jäger mobilized biological and astrophysical differences to suggest that the spider web and the cosmic web might nevertheless enter into a 'zone of proximity' or 'indiscernibility' based on specific processes of coding, weaving, and inscription.[51] Such real or imagined proximities are also haecceities of nonhuman and technical entities, inviting questions of their capacities to be related.

There is an imaginative thread in such speculations of creaturely, cosmic, and technical haecceity that is illuminating to an artistic practitioner like Saraceno. Indeed, on numerous occasions, I have witnessed Saraceno's commitment to cosmic image-making and storytelling.[52] Still, the speculations of Springel and Jäger, and Saraceno's interest in cosmic structure, do not wholly account for the reason why the artist and his collaborative team persisted in the project of simulating a black widow's web in three dimensions in order to relate it to the Millenium Simulation. A better answer, as I will elaborate, is that the practice of simulation was a site for experimentation and was generative of new images that challenged human skillsets while producing visceral, tactile knowledge on spider-web structure. To carry this insight further, the next section relates how a black widow spider, a technical apparatus, and a team of architects, scientists, and artists produced the first ever three-dimensional simulation of a spider web.

Simulation: capturing the web

Yes, now it's working. We can show you our machine … (Tomás Saraceno)[53]

This section will convey the production of digital simulations of a black widow's web in an expanded series of experiments at Studio Saraceno. The word 'simulation' derives from the Latin *simulāre*, which means 'to represent exactly, to copy, to imitate', hence, 'to feign'.[54] In contrast, Deleuze argues that simulations 'are not simply copies of copies'.[55] Deleuze testifies, 'to the persistent activity on the part of simulacra, to their underground work and to the possibility of a world of their own'.[56] Simulation, for Deleuze, is 'the different, the dissimilar, the unequal – in short, becoming'.[57] These philosophical statements resonate in the writing of Dowling, who claims that there is a 'useful ambiguity' expressed in simulation in scientific practices: 'simulation plays *different roles* according to the requirements of the narrative'.[58] In the present account, simulation is manifested in an experimental process that creates new aesthetic and epistemological relations between humans and spiders, cosmic and creaturely webs.

Early in this process, Saraceno and Krell visited Goethe University Hospital to attempt a computer tomography scan of the black widow's web.[59] The scans at the hospital were unsuccessful, even after various aerosols were added to make the web *thicker*. Ultimately, the black widow's threads evaded the vision of computer tomography devices: for these technologies, the web was a form of dark matter, *matter which you can't really see.* Many other methods of web capturing were tested, including some videographic methods: Krell told me, 'in the studio … we were thinking to

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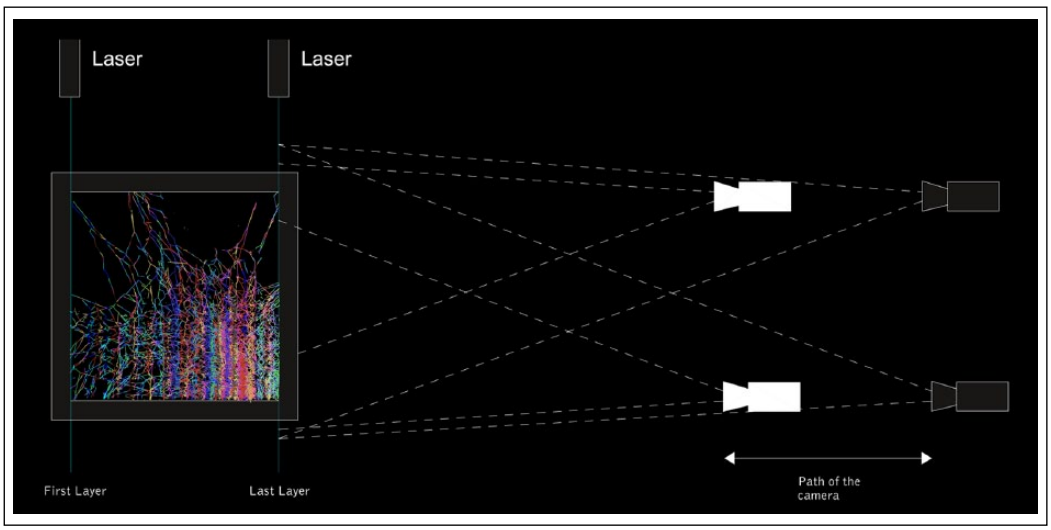

Figure 2. The technical elements of the machine.
The colored area inside the box represents the black widow's web. From Saraceno and Arrhenius (2010) *14 Billions (Working Title)* (pp. 27).
©Studio Tomás Saraceno, 2010.

make a video [of the spider weaving] and then to combine all the dots [and] all the data … but this didn't work'.[60]

The team at Studio Saraceno identified another method: that of stereoscopic (three-dimensional) images of Earth's surfaces. This technique, they determined, might succeed in recording the ultra-fine threads of the black widow's web. At the Technical University of Darmstadt, scientists were testing a stereo-photographic method for aerial landscape surveys. Saraceno and his team visited the laboratories of Dipl. Eng Dieter Steineck, Dipl. Eng. Christof Wulff, and Dipl. Eng. Rolf Dieter Dueppe. The scientists were intrigued by the notion of testing a method of 'web-capture' using stereo-photography: an application of their method that they had not encountered. After some discussion, and a rush to purchase a very thin laser, the expanded team tested a technical set-up whereby a sheet laser illuminated the spider web, highlighting the threads and nodes in its path (see Figure 2).[61] The team employed two cameras, a Canon EOS 5D Mark II and Canon TS-E 90 mm Lens, 147 cm from the laser sheet, and 20 cm from each other. As the sheet laser moved incrementally, another two images were captured. In this way, 110 pairs of stereoscopic-photogrammetric pictures were taken of the spider web. By combining the images from the right camera with those from the left, the image-product would have depth.

Saraceno wrote,

> The laser intercepted the spider web and caused extremely small dots to appear on the intersections. *A starry night seemed to appear before us in the picture, and so the cosmos and galaxies were yet again with us!*[62]

The cosmic web was there, '*yet again*'. In photographs of the laser slices of the spider web (see Figure 3), the red strands are highlighted like the strands of dark matter in the Millennium Simulation. However, it was the *filaments becoming visible*, as if emerging uniformly from darkness, like a 'flight' in the cosmic model, which most conjured the cosmic web for Saraceno and Krell.[63] At that moment, human practitioners perceived a 'zone of indiscernibility' between the

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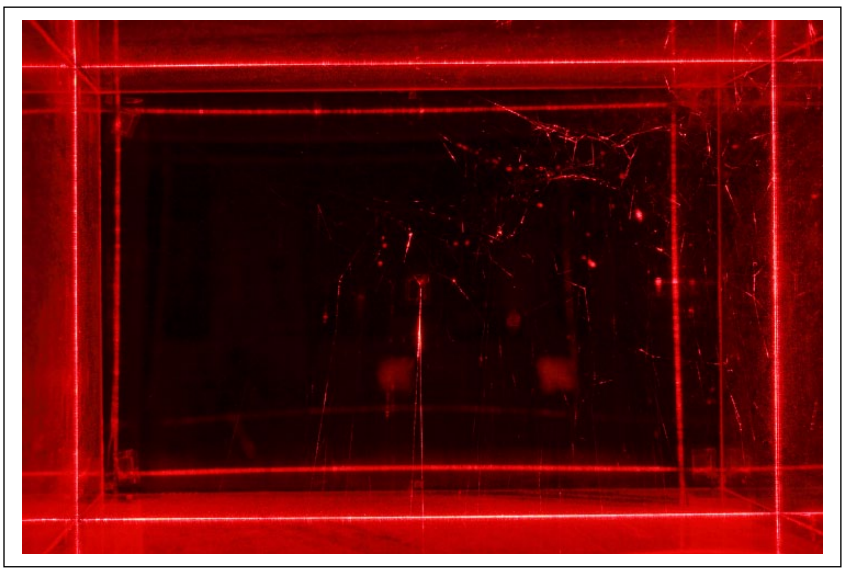

Figure 3. Solitary musical instrument Triangulum built by Latrodectus mactans.
Stereoscopic capture, left camera, 2014.
Courtesy the artist. ©Studio Tomas Saraceno, 2014.

spider web structure and the simulation of cosmic structure.[64] Each image – of the laser-illuminated spider web and the computer-simulated cosmic web – approached the other while remaining different from the other. In doing so, this process of simulation produced another haecceity that resonated with the practitioners in the laboratory. And in the spirit of Deleuze's notion of simulation, the laser-scan was generative of 'a world of [its] own'.[65] The technical apparatus in the laboratory, and the socio-material machine that conditioned its operation, had produced another cosmic web in the illuminated filaments of the spider web.

Sauvagnargues argues that no image, like the laser-scan described above or the black widow's web, is independent of the myriad other images that animate its machinic milieu.[66] This ecology of images is the identifying quality of the *artmachine*. Let us attend further, then, to the artmachine in which the laser-image emerged. This machine included material, technical, organic, and social components. It included the institutions of art and academy supporting human and nonhuman participants, namely Tanya Bonakdar and Esther Schipper Galleries; the Venice Biennale; the Technical University of Darmstadt; and wider institutional discourses on art-science experimentation. It included flows of raw material, data, capital, and expertise.[67] Framed in this way, the commitments exercised by the studio team, the availability of spaces and materials of production, and the weaving of a spider become much less predictable. Yet, we can recognize this ecological milieu as it concretizes in events of experimenting, becoming, and witnessing – of simulation and haecceity – between humans, spiders, and webs.

In the laboratory, then, practitioners carefully positioned a number of technical devices around the black widow's web. Where was the spider? As Lefebvre explains, a spider web is an extension of 'those dualities which help constitute the body as they do the animals' relationship to itself and its productive and reproductive acts'.[68] Therefore, although the black widow had been removed from the web before the laser-scans, and had taken up another web-residence at the studio, she remained materially present in the organic structure she had excreted. Next, by projecting a plane

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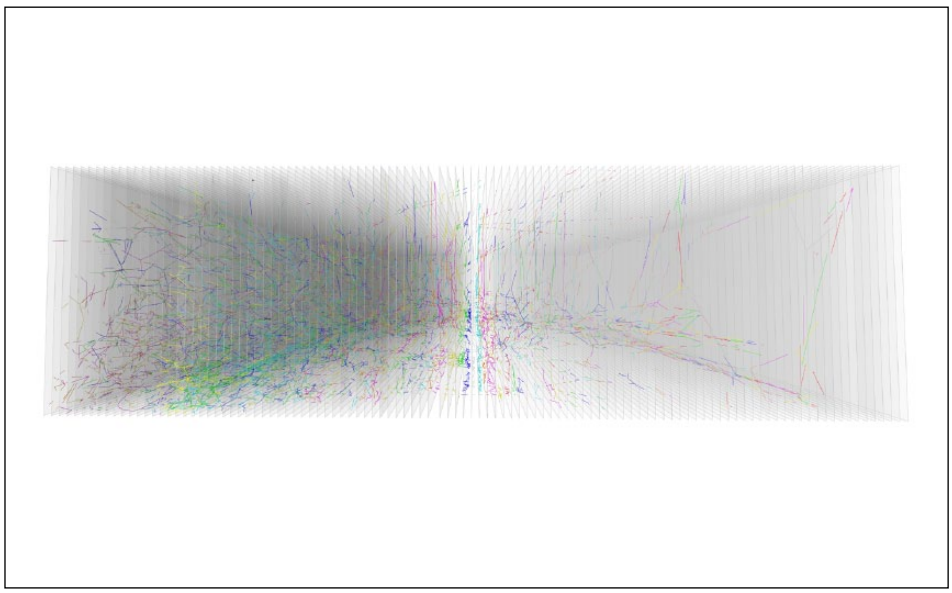

Figure 4. Three-dimensional file is prepared for the installation.
From Saraceno and Arrhenius (2010) *14 Billions (Working Title)* (pp. 62–3). Commissioned by Bonniers Konsthall. Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin; ©Studio Tomás Saraceno, 2010.

of radiation through the Plexiglas box, the sheet laser highlighted points and vector fragments on a plane (Figure 2). In the darkness, light wave-particles traveled from the illuminated points to the two camera lenses. The sensor chips of the digital cameras broke each transmission into millions of pixels. The sensors measured the color and brightness of each pixel and recorded it as a number. From these intervals of illumination, recording, and transmission, the spider web was rendered as light and code. The entire apparatus was machinic in the sense elaborated by Schuppli following Deleuze and Guattari: it was a composition that 'organize[s] matter and form into new relations: matter ceases to be a question of content, becoming instead a matter of expression'.[69] We can think of this technical apparatus and its conditions of operation in the terms of the artmachine, because the different matters of 'capture' and expression, from the physical spider web to the laser-scans and the signatures of binary code, form an ecology of images that are not reproductive or mimetic, but exert varying degrees of movement and force on each other and on their milieu. This ecology of images is not limited to what was produced at Studio Saraceno, but includes the cosmic web and the Millenium Simulation discussed earlier.

Another stage in this experiment further accentuates the shifting relations between humans and webs. The vast quantity of stereo-photogrammetric data collected by the optical-technical apparatus was processed at Studio Saraceno. The data were input into a CAD (computer-assisted design) system. In doing so, the team found that the capturing was not 100 percent complete (see Figure 4). There were tiny gaps in between the laser-generated 'slices' where the spider's threads were not recognized by the camera sensors. The presence of these holes meant that the machine had failed in producing a complete simulation. However, it was precisely this failure that inspired new possibilities of becoming. Indeed, for Sauvagnargues, failure is necessary: 'the machine works by breaking down'.[70] After a brief discussion with structural engineers Bollinger and Grohman, members of Studio Saraceno determined that the digital simulation would have to be

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completed manually. Four architects then followed the direction of *every thread* in the simulation, closing the gaps. To do so, they rotated the simulation on its axis, 'spinning' the web.[71] These architects practiced web weaving. They also 'tinkered' with the simulation, just as many scientists do.[72] In this moment of machinic breakdown, the terms architect and scientist, human and spider were partially suspended: assisted by computer design software, humans honed *arachnean arts* of connecting and weaving.

A variety of technical, aesthetic, and collaborative steps, thus, transformed relations between humans, spiders, and webs. The reweaving of these relations constituted epistemological and aesthetic events that escape representative analysis. In such an engagement with multispecies experiments, thinking-with the artmachine is 'less a question of a radical shift or even of a theoretical leap than a spiraling amplification' of expressive ecologies that cannot be bordered by definitions of art, technology, or science.[73] The poetic translations of a spider's web from silk to code to digitally-rendered model are partially driven by human practitioners, and yet, these webs' haecceities and simulations challenge the skills of human practitioners and the boundaries of human disciplines. Novel propositions and sensations emerge in the gaps and interstices. The next stage in the experiment, in which an art installation is produced and displayed, further elaborates the images and ecologies of the artmachine.

Weaving the artmachine: *14 Billions (Working Title)*

Once the three-dimensional computer simulation of the black widow spider web was almost complete, Saraceno and his studio team began to prepare a *physical simulation*, over 16 times the scale, of the original spider web. The goal was to reconstruct the spider web in a gallery. First, the studio team produced an orthogonal projection of the web (a flattening in two dimensions). This orthogonal image was placed in mirrored reflection on the floor and ceiling of a purpose-built cube inside a helicopter hangar. At each intersection between floor and ceiling, the practitioners strung a length of fishing wire. They employed a 'book of numbers' which recorded the heights at which the black widow's threads intersected with the fishing wire. The assistants used the projection, the fishing wire scaffolding, and the book of numbers to tie and connect all the nodes. There were 6593 nodes and 11,987 line segments in total. As one team worked in the hangar, the architects back at the studio were still finishing the 'spinning' of the three-dimensional data. Referring to the parallel constructions of multiple digital and physical spider webs, then studio member Jol Thomson remarked, 'The funny thing about making a web … is that you need another web!'.[74]

Together with Saraceno, Thomson participated in assembling the large-scale three-dimensional black widow web. He emphasized the hours spent 'weaving' with two teams working in day-night shifts in the hangar.[75] He commented, '*some of us became spiders and some became prey*', alluding that for some practitioners, the web 'made sense'.[76] The web even made its way into dreams. Thomson likened the experience to the feeling of having an afterimage burned on one's retina after looking at a silhouette in a sunny window.[77] The web in the digital file, the 'under web' of fishing wire, and the emerging filaments of the new scaled-up web overlapped in space. Constructing the area corresponding to the 'retreat' of the black widow was the most difficult, since this was the area of the highest density of nodes (4255 line segments in total). At this stage, Thomson later described, the work was less about objective precision than a visual-tactile awareness of the nodal connections. Dowling writes of computer simulators that '[a] sense of direct manipulation encourages simulators to develop a "feel" for their mathematical models with their hands and their eyes, by tinkering with them, noticing how they behave, and developing a practical intuition for how they work'.[78] The 'direct manipulation' practiced by the studio team generated an intuition for the black

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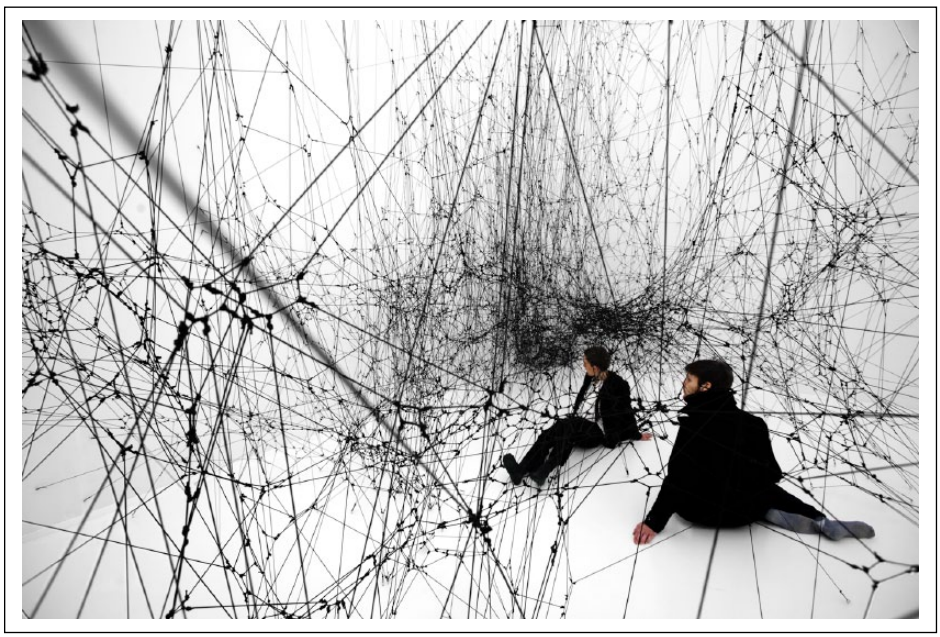

Figure 5. Tomás Saraceno, *14 Billions (Working Title)*, 2010.
Installation view, Bonniers Konsthall, Stockholm. Commissioned by Bonniers Konsthall.
Courtesy the artist; Tanya Bonakdar Gallery, New York; Andersen's Contemporary, Copenhagen; Pinksummer contemporary art, Genoa; Esther Schipper, Berlin. ©Studio Tomás Saraceno, 2010.

widow's weaving and opened a space in which the web exerted its own expressive force on humans. It is no wonder they dreamed the web, too.

The scaled-up physical web was successfully shipped to Stockholm and formed the art installation *14 Billions (Working Title)* (2010) at the Bonniers Konsthall Museum (Figure 5). While the installation can be interpreted in a variety of meaningful ways, for example, as a metaphor for a politics of inclusion and encounter (as elaborated by Closs Stephens and Squire[79]), in this article I offer a very different perspective. This account demonstrates that *14 Billions* is not a discrete object, but is part of an ecology of images circulating in the sociotechnical space of the art studio and more widely in astrophysics, computing, culture, and biology. To the extent that this ecology of images concretizes in a recognizable project and multi-sited experiment, a novel collective individuation is achieved, one that is not characterized by a constellation of human actors, but by promiscuous relations between techno-aesthetic, human, and nonhuman images. Furthermore, as related in this section, the laborious construction of the installation generated powerful affective and dream-encounters for practitioners. This supports Sauvagnargues statement: 'To talk about the art machine is at the same time to affirm the functionality of art and the integration of technical processes into modes of subjectification'.[80] In the construction of *14 Billions*, and in the 'functional' processes of scanning, imaging, and modeling detailed earlier, webs expressed and influenced subjective states.

The title *14 Billions* refers to the approximate age of the universe. It is a title that underscores that the process of simulating a black widow's web was ultimately *not* about a strict homology-focused comparison between the structure of the spider's web and the Millenium Simulation. Rather, the simulation of a spider web became a technique for experimenting with cosmic structure using

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different terms, practices, and imaginaries, including the practices of an invertebrate animal. It was a process that generated another story of cosmic complexity, another way of narrating and grasping the filamentary structure in which life on Earth participates. The many cosmic and creaturely haecceities and simulation(s) discussed here, including the installation *14 Billions*, chart the constellation of an artmachine that has aesthetic and epistemological significance, to be evaluated further in this paper's conclusion.

The promise of the artmachine

In this article, I have discussed the machinic relations between a black widow spider's web and astrophysical models of the 'cosmic web', paying attention to the images circulating between creaturely, human, scientific, and technical processes. In doing so, I have employed the artmachine: a term and lens that illuminates processes of capturing, recording, and simulating whereby the web of a spider was made legible for optical devices, human practitioners, computer systems, and museum-goers alike. If we think with the artmachine, these forms of legibility are not representational; they are events, or *haecceities*, of individuation and becoming. Haecceities can emerge from practices of *simulation* that blur distinctions between disciplines and methods, as well as human and arachnean arts. Through this work, I have sought to make two contributions. First, I have proposed the artmachine as part of a grammar for geographical approaches to techno-aesthetic and multispecies experiments in art; second, I have offered an account of these experiments that emphasized moments of imaging and 'capture' propagating across human, nonhuman, and technological assemblies. It is this ecology of images, rather than the constellation of human expertise, that constitutes the terrain of art, one that threads its way through biological, technical, and cultural spheres. In this way, I have resisted asserting a specific cultural aesthetics to art and to the experiments addressed here. Instead, art emerges in the materialization of cosmic, biological, and sociotechnical forces that expose the weaving (of spider webs, dark matter webs, code, laser-illumination, simulation, and sculpture) to affective elaboration and experimentation.

In this conclusion, I will present three additional insights for cultural geography. First, the artmachine might serve as impetus for machinic approaches to artistic coproduction and collaboration. Indeed, the artmachine may find purchase among scholars who question the anthropomorphism of arts practice[81] and those who probe the disciplinary porosities of art and geography.[82] It may also engage scholars applying creative sensing methodologies to animal worlds,[83] as well as to spheres of the inhuman and inorganic.[84] Equally, the artmachine may support geophilosophies of media interested in the connections between fabricated images and geophysical transformations.[85] If such projects find resources in the artmachine, their task will be to trace art's emergence in ecologies of images, in interactions between material, biological, technical, and social events. It will mean apprehending art as a sensual, affective force without falling back on default notions of where art emerges, or takes place. If Williams, among others, challenges geographers to become 'more precise' about modes of creativity,[86] an attendant challenge, following Sauvagnargues, is to resist establishing creativity or artfulness in advance of the machinic conditions of individuation and becoming.

The second insight concerns the transparency of technical mediation in disciplinary attentions to artistic practice and research. The historian of science Rheinberger suggests, 'it is important to develop an awareness of the *thickness* or *untransparency* that comes with the use of … instrumentation'.[87] A series of geographical works by Dixon, Hawkins and Straughan, and Lapworth have engaged with technologies of bio-art and nano-art in order to critique the humanist assumptions that frame the lively materials in the art studio.[88] Others have developed

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attentions to the technocultural practices of video games[89] and to the simultaneous transparency (resolution) and envelopment (power) of screens.[90] In resonance with this work and geographies of experiment in this journal and elsewhere,[91] the artmachine may help us address the 'thickness' of artistic research. It may guide us in attending to the machinic arrangements of devices, materials, and media that expand to the architecture of the studio, lab, or desk and the knowledge formations beyond it. In the experiment chronicled here, 'thickness' has a literal meaning, since the experiments with spiders and simulations revolved around the 'making-thick' of the black widow's web. A critical element in the wider agenda of the artmachine will be to account for 'the integration of technical processes into modes of subjectification' as part of a project that understands art as emergent from, rather than elevated above or subservient to, technical practices.[92]

Third, and more generally, there is important aesthetic, epistemic, and cultural value in critical attention to the machinic qualities of artistic research and practice. Scholars employing machinic thinking in geography have approached trance in Goa,[93] material agency in IKEA,[94] and the 'anticipatory machine' of cartographic research.[95] However, beyond Hawkins' characterization of art as a difference-producing machine,[96] geographical approaches to machines of art have been few.[97] The artmachine may offer resources for such scholarship. In addition, operationalizing the attentions of artmachines in cultural geography enlarges possibilities for thinking about the futurity of artistic experiments: for considering the ways in which such experiments must be precisely assembled and yet are always open to the unexpected, the unknown. This futurity is not reducible to the logic of discovery, but is part of art's geoaesthetic impetus.[98] The stakes of the artmachine coalesce in an ecological apprehension of images and their worlds: images and worlds that, much like webs of dark matter, are continually woven anew.

Epilogue

On 12 October 2017, Neyrinck et al. published a paper in *Cosmology and Nongalactic Astrophysics* journal that proved, using principles of structural engineering, that the physical structure of a spider web is indeed a good approximation for the physical structure of the cosmos.[99] In a blog written for the *Huffington Post* on the 31 October, Neyrinck wrote,

> '14 Billions' refers to the age of the universe in years, and to cosmic structure … Saraceno included '(working title)' in the title because of the uncertain relationship between arachnid and cosmic webs … But as we found, there is a physical similarity![100]

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Notes

1. T.Saraceno and S.Arrhenius (eds) *14 Billions (Working Title)* [exhibition catalogue for Tomás Saraceno's exhibition at Bonniers Konsthall] (Milan: Skira, 2010).
2. See: S.Engelmann, 'Social Spiders and Hybrid Webs at Studio Tomás Saraceno', *cultural geographies in practice*, 24, 2017, pp. 161–9.
3. See for example: F.Ginn, 'Sticky Lives: Slugs, Detachment and More-than-Human Ethics in the Garden', *Transactions of the Institute of British Geographers*, 39, 2014, pp. 532–44; D.Dixon, 'The Blade and the Claw: Science, Art and the Creation of the Lab-Borne Monster', *Social & Cultural Geography*, 9, 2008, pp. 671–92; J.Lorimer, 'Gut Buddies: Multispecies Studies and the Microbiome', *Environmental Humanities*, 8, 2016, pp. 57–76; J.Lorimer, 'Parasites, Ghosts and Mutualists: A Relational Geography of Microbes for Global Health', *Transactions of the Institute of British Geographers*, 42(4), 2017, pp. 544–558; A.L.Tsing, '*The Mushroom at the End of the World'*, (Princeton: Princeton University Press, 2015); T.Van Dooren, 'The Last Snail', in A.Springer and E.Turpin (eds) *Land, Animal and Nonanimal* (Berlin: Haus der Kulturen der Welt, 2015).
4. G.Davies, 'Caring for the Multiple and the Multitude: Assembling Animal Welfare and Enabling Ethical Critique', *Environment and Planning D: Society and Space*, 304, 2012, pp. 623–38; G.Davies, 'Mobilizing Experimental Life: Spaces of Becoming with Mutant Mice', *Theory, Culture & Society* 30(7–8), 2013, pp. 129–53; B.Latour, *Pandora's Hope: Essays on the Reality of Science studies* (Boston: Harvard University Press, 1999).
5. Dixon, 'The Blade and the Claw', p. 675.
6. V.Despret and M.Meuret, 'Cosmoecological Sheep and the Arts of Living on a Damaged Planet', *Environmental Humanities*, 8(1), 2016, pp. 24–36.
7. For example, see: D.Dixon, 'Creating the Semi-Living: On Politics, Aesthetics and the More-than-Human', *Transactions of the Institute of British Geographers*, 34(4), 2009, pp. 411–35; A. Lapworth, 'Habit, Art, and the Plasticity of the Subject: The Ontogenetic Shock of the Bioart Encounter', *cultural geographies*, 22(1), 2015, pp. 85–102; H.Hawkins and E.R.Straughan, 'Nano-art, dynamic matter and the sight/sound of touch', *Geoforum*, 51, 2014, pp. 130–39; E.R.Straughan, 'A Touching Experiment: Tissue Culture, Tacit Knowledge, and the Making of Bioart', *Transactions of the Institute of British Geographers*, 44(2), 2019, pp. 214–225; G.Born and A.Barry, 'Art-Science: From Public Understanding to Public Experiment', *Journal of Cultural Economy*, 3(1), 2010, pp. 103–19; T.Roberts, 'From Things to Events: Whitehead and the Materiality of Process', *Environment and Planning D: Society and Space*, 32(6), 2014, pp. 968–83.
8. A.Sauvagnargues, *Artmachines: Deleuze, Guattari, Simondon* (Edinburgh: Edinburgh University Press, 2016).
9. G.Deleuze and F.Guattari, *Anti-Oedipus* (Minneapolis: University of Minnesota Press, 1984); Sauvagnargues, *Artmachines*.
10. Sauvagnargues, *Artmachines*, p. 186.
11. Sauvagnargues, *Artmachines*, p. 46.
12. Sauvagnargues, *Artmachines*, p. 53.
13. See: G.Simondon, 'The Position of the Problem of Ontogenesis', *Parrhesia*, 7(1), 2009, pp. 4–16.
14. Sauvagnargues, *Artmachines*, p. 138–50; See also: E.Manning, 'Always More than One: The Collectivity of a Life', *Body & Society*, 16(1), 2010, pp. 117–27.
15. Sauvagnargues, *Artmachines*, p. 53.
16. Sauvagnargues, *Artmachines*, p. 47.
17. A.Sauvagnargues, 'Design Machines and Art Machines', in B.Marenko and J.Brassett (eds) *Deleuze and Design* (Edinburgh: University of Edinburgh Press, 2015) pp. 78.
18. Sauvagnargues, *Artmachines*, p. 47.

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19. For example see A.C.Stephens and V.Squire, 'Politics through a web: citizenship and community unbound', *Environment and Planning D: Society and Space*, 30(3), 2012, pp. 551–67; B.Latour, 'Some Experiments in Art and Politics', *E-flux*, 23, 2011, pp. 1–7.
20. See D.Rothenberg, 'Spider Music', *PAJ: A Journal of Performance Research*, 40(1), 2018, pp. 31–6; M.Buehler, 'Imaging and Analysis of a Three-Dimensional Spider Web Architecture', *Journal of the Royal Society Interface*. Epub ahead of print 19 September 2018. DOI: 10.1098/rsif.2018.0193; see also S. Engelmann, Social spiders and hybrid webs.
21. See, for example, S.Schuppli, 'Of Mice moTHS AND meN mAcHiNeS', *Cosmos and History: The Journal of Natural and Social Philosophy*, 4(1–2), 2008, pp. 286–306.
22. On 9 September 1947, a technician in the laboratory of computational pioneer Grace Hopper solved a 'glitch' by pulling a peppered moth out of the Harvard Mark II machine: an electromechanical computer used by the US Navy for gunnery and ballistic calculations. Schuppli re-narrates in poetic terms:

    > The 'living' … had inadvertently entered into the Harvard Mark II computer causing a computational glitch or crack in its machinic mold as its fluttering gesticulations interfered with the transmissional regimes of its relays. The moth's dynamic vitality introduced a kind of surplus or aberrant code into the machine, which in effect pushed the machine towards a state of chaos and breakdown. (Schuppli, 2008: 288)

23. For example: L.Gibbs, 'Arts-science collaboration, embodied research methods, and the politics of belonging: 'SiteWorks' and the Shoalhaven River, Australia', *cultural geographies*, 21(2), 2014, pp. 207–27; D.Overend and J.Lorimer, 'Wild Performatives: Experiments in Rewilding at the Knepp Wildland Project', *GeoHumanities*, 4, 2018, pp. 527–42; D.McNally, 'Collaboration as Acknowledged Co-production: A Site-Based Approach to Tribe', *cultural geographies*, 25(2), 2018, pp. 339–59; H.Hawkins, S.A.Marston, M.Ingram & E.Straughan, 'The Art of Socioecological Transformation', *Annals of the Association of American Geographers*, 105(2), 2015, pp. 331–41; M.Fowkes and R.Fowkes, 'The Primeval Cosmic River and Its Ecological Realities: On the Curatorial Project Danube River School', *GeoHumanities*, 2(2), 2016, pp. 453–68.
24. For an account of collective individuation of humans and technical visualizing objects, see: K.Woodward, J.P.Jones III, L.Vigdor, S.A.Marston, H.Hawkins and D.P.Dixon 'One Sinister Hurricane: Simondon and Collaborative Visualization', *Annals of the Association of American Geographers*, 105(3), 2015, pp. 496–511.
25. N.Williams, 'Creative Processes: From Interventions in Art to Intervallic Experiments through Bergson', *Environment and Planning A*, 48(8), 2016, pp. 1549–64.
26. G.Deleuze and F. Guattari, *A Thousand Plateaus*, trans. by Brian Massumi (Minneapolis: University of Minnesota Press, 1980 [1987]) pp. 260; see also S.O'Sullivan, 'Memories of a Deleuzian: To Think is Always to Follow the Witches' Flight', in H.Somers-Hall, J.A.Bell, J.Williams (eds) *A Thousand Plateaus and Philosophy Reader* (Edinburgh: Edinburgh University Press, 2018) pp. 172–89.
27. Deleuxe and Guattari, *A Thousand Plateaus*, p. 260.
28. Deleuze and Guattari, *Anti-Oedipus*.
29. Sauvagnargues, A*rtmachines*, p. 51.
30. G.Deleuze, 'Literature and Life', *Critical Inquiry*, 23(2), 1997, pp. 225–30; Sauvagnargues, *Artmachines*, p. 50.
31. M.Delanda, *Philosophy and Simulation: The Emergence of Synthetic Reason* (London: Bloomsbury Publishing, 2011) p. 34.
32. T.Saraceno, *14 Billions (Working Title)* (art installation) (Stockholm: Bonniers Kunsthalle, 2010).
33. F.Capra, *The Web of Life* (New York: Anchor Books, 1996).
34. K.N. Hayles, The Cosmic Web: Scientific Field Models and Literary Strategies in the Twentieth Century (Cornell: Cornell University Press, 1986).
35. M.Hansen, *Feed-Forward: On the Future of Twenty-First-Century Media* (Chicago, IL: The University of Chicago Press, 2015).
36. J.R.Bond, Lev Kofman, and Dmitri Pogosyan, 'How Filaments are Woven into the Cosmic Web', *arXiv preprint astro-ph/9512141*, 1995<https://arxiv.org/abs/astro-ph/9512141>; Mark Neyrinck, personal communication with author (2017).

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37. See for example V.De Lapparent, M.J.Geller, and J.P.Huchra, 'A Slice of the Universe', *The Astrophysical Journal*, 302, 1986, pp. L1–L5.
38. Max Planck Society, 'Supercomputer Simulations Explain the Formation of Galaxies and Quasars in the Universe', 2 June 2005<https://www.mpg.de/research/supercomputer-simulations-galaxies-quasars-universe> (July 2 2015).
39. V.Springel, S.D.White, A.Jenkins, C.S.Frenk, N.Yoshida, L.Gao, and F.Pearce, 'Simulations of the Formation, Evolution and Clustering of Galaxies and Quasars', *Nature*, 435(7042), 2005, pp. 629–36.
40. Astrophysics Journal Letters, 'Flies in a Spider's Web: Galaxy Caught in the Making', 12 October 2006<http://www.esa.int/Our_Activities/Space_Science/Flies_in_a_spider_s_web_galaxy_caught_in_the_making> (3 April 2015).
41. In humanistic spheres, the concept of the 'cosmic web' became promiscuous, permeating literary works such as Borges' *Ficciones* and Pynchon's *Gravity's Rainbow* (Hayles, 1984). In theoretical cosmology and physics, the 'cosmic web' is a lively focus of mathematical modeling and speculation in which methods of origami are implicated, as evidenced by the work of Neyrinck et al. (2017).
42. H.M.Courtois, D.Pomarède, R.Brent Tully, Y.Hoffman and D.Courtois, 'Cosmography of the Local Universe', *The Astronomical Journal*, 146(3), 2013, p. 69.
43. I.Prigogine and I.Stengers, *Entre le temps et l'éternité* (Paris, Fayard, 1988).
44. K.Barad, 'No Small Matter: Mushroom Clouds, Ecologies of Nothingness, and Strange Topologies of Spacetimemattering', in A.Tsing, H.Swanson, N.Bubandt, and E.Gan (eds) *Arts of Living on a Damaged Planet* (Minneapolis: University of Minnesota Press, 2017), p. 103.
45. D.Whitehouse, 'When the Universe was 'Spongy'', *BBC Science and Technology News* <http://news.bbc.co.uk/2/hi/science/nature/1345134.stm> (3 March 2014).
46. V.Springel in T.Saraceno, (ed.), *Venice Biennale Catalogue* (Venice: Studio Saraceno, 2009) p. 44.
47. Springel in Saraceno, *Venice Biennale Catalogue*, p. 44.
48. Sauvagnargues, *Artmachines*, p. 51.
49. Jäger in Saraceno, *Venice Biennale Catalogue*, p. 44.
50. Jäger in Saraceno, *Venice Biennale Catalogue.*
51. For 'zone of indiscernibility' see G.Deleuze, 'Literature and Life'. See also G.Deleuze and F.Guattari (1987), *A Thousand Plateaus*:

    > A becoming is neither one nor two, nor the relation of the two; it is the in-between, the border or line of flight or descent running perpendicular to both. If becoming is a block (a line-block), it is because it constitutes a zone of proximity and indiscernibility, a no-man's-land, a nonlocalizable relation sweeping up the two distant or contiguous points, carrying one into the proximity of the other … (p. 293)

52. Saraceno, *Venice Biennale Catalogue*, p. 44.
53. T.Saraceno to P.Jäger, *Venice Biennale Catalogue*, p. 70.
54. E. Partridge, *Origins: A Short Etymological Dictionary of Modern English* (Abingdon: Routledge, 2006).
55. G.Deleuze, *Difference and Repetition* (New York: Columbia University Press, 1994).
56. Deleuze, '*Difference and Repetition*', p. 128.
57. Deleuze, '*Difference and Repetition*', p. 128.
58. D.Dowling 'Experimenting on Theories', *Science in Context*, 12(2), 1999, p. 263.
59. Krell, 'personal interview with author', (Berlin: Studio Saraceno, 2014), np.
60. Krell, 'personal interview', np.
61. At this point the black widow spider was no longer in the web, having taken up residence in another web at Studio Saraceno.
62. Saraceno, *Venice Biennale Catalogue*, p. 15, original emphasis.
63. Krell, 'personal interview', np.
64. Deleuze, '*Literature and Life*'.
65. Deleuze, '*Difference and Repetition*', p. 128.
66. Sauvagnargues, *Artmachines*.
67. Sauvagnargues, *Design Machines and Art Machines*, p. 62.

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68. H.Lefebvre, *The Production of Space*, vol. 142 (Oxford: Blackwell, 1991) p. 173.
69. Schuppli, 'Of Mice', p. 289.
70. Sauvagnargues, *Artmachines*, p. 193.
71. J.Thomson, 'personal interview with author', (Berlin: Studio Saraceno, 2014), np.
72. Dowling, '*Experimenting*'.
73. Sauvagnargues, *Artmachines*, p. 48.
74. Thomson, 'personal interview', np.
75. Thomson, 'personal interview', np.
76. Thomson, 'personal interview', np.
77. Thomson, 'personal interview', np.
78. Dowling, '*Experimenting*', p. 269.
79. A.Closs Stephens and Vicki Squire, 'Politics through a Web: Citizenship and Community Unbound', *Environment and planning D: Society and Space*, 30(3), 2012, pp. 551–67.
80. Sauvagnargues, *Design Machines and Art Machines*, p. 79.
81. D.Dixon, H.Hawkins and E.Straughan, 'Of Human Birds and Living Rocks: Remaking Aesthetics for Post-Human Worlds', *Dialogues in Human Geography*, 2(3), 2012, pp. 249–70; A.Lapworth, 'Habit, Art, and the Plasticity of the Subject'; L.Gibbs, 'Arts-Science Collaboration'; Dixon, 'The Blade and the Claw'.
82. E.Magrane, 'Situating Geopoetics', *GeoHumanities*, 1(1), 2015, pp. 86–102; H.Hawkins, L.Cabeen, F.Callard, N.Castree, S.Daniels, D.DeLyser, H.Munro Neely, and P.Mitchell, 'What Might GeoHumanities Do? Possibilities, Practices, Publics, and Politics', *GeoHumanities*, 1(2), 2015, pp. 211–32.
83. J.Lorimer, 'Moving Image Methodologies for More-than-Human Geographies', *cultural geographies*, 17(2), 2010, pp. 237–58; V.Despret and B.Buchanan, '*What Would Animals Say If We Asked the Right Questions?*' (Minneapolis: University of Minnesota Press, 2016); Blue, 2016; Forsyth, 2013); J.Brigstocke and T.Noorani, 'Posthuman Attunements: Aesthetics, Authority and the Arts of Creative Listening', *GeoHumanities*, 2(1), 2016, pp. 1–7; G.Blue, 'Public Attunement with More-than-Human Others: Witnessing the Life and Death of Bear 71', *GeoHumanities*, 2(1), 2016, pp. 42.
84. F.Ginn, 'When horses won't eat: Apocalypse and the Anthropocene', *Annals of the Association of American Geographers*, 105(2), 2015, pp. 351–59; K.Yusoff, 'Geologic Subjects: Nonhuman Origins, Geomorphic Aesthetics and the Art of Becoming in Human', *cultural geographies*, 22(3), 2015, pp. 383–407.
85. J.Parikka, 'A Geology of Media' (Minneapolis: University of Minnesota Press, 2015); B.Bratton, 'The New Normal 2018: Final Project Review Day. Day 1', *Video Documentation* <http://youtu.be/X2H6rBSuJUI>; Multiple Authors, GeoCinema Network, <http://www.geocinema.network/>
86. Williams, 'Creative Processes'.
87. H.Jorg Rheinberger, 'Forming and Being Informed', Interview with Michael Schwab', in M.Schwab (ed.) *Experimental Systems: Future Knowledge in Artistic Research* (Leuven: Leuven University Press, 2013), p. 203; my emphasis.
88. Dixon, 'The Blade and the Claw', p. 671; Deborah Dixon, 'Creating the Semi-living: On Politics, Aesthetics and the More-than-Human', *Transactions of the Institute of British Geographers*, 34(4), 2009, pp. 411–25; Hawkins and Straughan 'Nano-Art'; A.Lapworth, 'Habit, Art, and the Plasticity of the Subject: The Ontogenetic Shock of the Bioart Encounter', *cultural geographies*, 22(1), 2015, pp. 85–102.
89. J.Ash and L.Anne Gallacher, 'cultural geography and Videogames', *Geography Compass*, 5(6), 2011, pp. 351–68.
90. J.Ash, *The Interface Envelope: Gaming, Technology, Power* (New York: Bloomsbury Publishing, 2015).
91. A.Last, 'Experimental Geographies', *Geography Compass*, 6(12), 2012, pp. 706–24; A.Enigbokan and M.Patchett, 'Speaking with Specters: Experimental Geographies in Practice', *cultural geographies*, 19(4), 2012, pp. 535–46; John-David Dewsbury, 'Inscribing Thoughts: The Animation of an Adventure', *cultural geographies*, 21(1), 2014, pp. 147–52; T.Jellis, 'Spatial Experiments: Art, Geography, Pedagogy', *cultural geographies*, 22(2), 2015, pp. 369–74.
92. Sauvagnargues, *Design Machines and Art Machines*, p. 79.
93. A.Saldanha, *Psychedelic White: Goa Trance and the Viscosity of Race* (Minneapolis: University of Minnesota Press, 2007).

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94. T.Roberts, 'From "New Materialism" to 'Machinic Assemblage': Agency and Affect in IKEA', *Environment and Planning A*, 44(10), 2012, pp. 2512–29.
95. J.Gerlach and T.Jellis, 'Guattari: Impractical Philosophy', *Dialogues in Human Geography*, 5(2), 2015, pp. 131–48.
96. H.Hawkins, *For Creative Geographies: Geography, Visual Arts and the Making of Worlds* (Abingdon: Routledge, 2013) p. 11.
97. For a perspective on art-machines from the arts, see: Kanarinka, 'Art-Machines, Body-Ovens and Map-Recipes: Entries for a Psychogeographic Dictionary', *Cartographic Perspectives*, 53, 2006, pp. 24–40.
98. Sauvagnargues, *Artmachines*, p. 47.
99. M.C.Neyrinck, J.Hidding, M.Konstantatou, R.van de Weygaert 'The Cosmic Spiderweb: Equivalence of Cosmic, Architectural, and Origami Tessellations', *arXiv preprint arXiv:1710.04509*, 2017 <https://arxiv.org/abs/1710.04509>
100. M.Neyrinck, 'The Cosmic Spiderweb on all Dark-Matter-Haloes' Eve', *The Huffington Post* <https://www.huffingtonpost.com/entry/the-cosmic-spiderweb-on-all-dark-matter-haloes-eve_us_59ecb449e4b092f9f2419314> (1 November 2017).

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